01 | The Tree of Life

As buds give rise by growth to fresh buds, and these, if vigorous, branch out and overtop on all sides many a feebler branch, so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever branching and beautiful ramifications.

—Charles Darwin

The distributions and partitions of knowledge are not like several lines that meet in one angle, and so touch but in a point; but are like branches of a tree, that meet in a stem, which hath a dimension and quantity of entireness and continuance, before it comes to discontinue and break itself into arms and boughs.

—Francis Bacon

Trees are among the earliest representations of systems of thought and have been invaluable in organizing, rationalizing, and illustrating various information patterns through the ages. As the early precursors of modern-day network diagrams, tree models have been an important instrument in interpreting the evolving complexities of human understanding, from theological beliefs to the intersections of scientific subjects. This favored scheme, usually highlighting a hierarchical ordering in which all divisions branch out from a central foundational trunk, is ultimately a universal metaphor for the way we organize and classify ourselves and the world around us.

The two epigraphs to this chapter are drawn from Darwin, *The Origin of Species*, 172; and Bacon, *Francis Bacon*, 189.

Sacred Trees

For thousands of years trees have been the subject of worship, esteem, and mythology. They are a common motif in world religions and a central theme in the art and culture of many ancient civilizations, from Babylon to the Aztecs. As symbols of prosperity, fertility, strength, and growth, trees have been considered sacred by, or have had an astral meaning to, numerous societies over the ages. With their roots firmly entrenched in the ground and branches reaching toward the skies, they embody a link between heaven, Earth, and the underworld—a unifying symbol of all elements, physical and metaphysical. "A tree that reaches into heaven," says Rachel Pollack, a science fiction writer and tarot expert, "is a very vivid and enticing metaphor, and so has proved useful to humans the world over as a way to formulate our desire to encounter the divine."[1]

For thousands of years, forests have had an impact on humans, not only as a symbol of the mysteries of nature but also as tangible providers of shelter and resources. In *The Real Middle Earth: Exploring the Magic and Mystery of the Middle Ages* (2002), Brian Bates explains how forests were considered places of magic and power, "like a great spirit which had to be befriended."[2] It is not surprising, notes Bates, that so many ancient folktales are set in the woods, as "forests seem to be a natural template for the human imagination."[3] Even though the West has lost its connection to nature as a divine revelation, many of these ancient myths still bear a considerable influence in contemporary society. "The folklore of the modern European peasant, and the observances with which Christmas, May Day, and the gathering of the harvest are still celebrated in civilized countries," explains J. H. Philpot, "are all permeated by the primitive idea that there was a spiritual essence embodied in vegetation, that trees, like men, had spirits, passing in and out amongst them, which possessed a mysterious and potent influence over human affairs."[4]

The romances of the Middle Ages contain innumerous fables of enchanted forests and gallant knights, with the woods serving as the perfect backdrop. The magic, however, started a long time ago. In his captivating *The Forest in Folklore and Mythology* (1928), Alexander Porteous explains the meaning of this primordial fascination:

> In the early strivings of the mind of primitive man to account for the scheme of creation, the tree took a foremost place, and the sky, with its clouds and luminaries, became likened to an enormous Cosmogonic Tree of which the fruits were the sun, moon, and stars. Many races of the earth evolved their own conception of a World Tree, vast as the world itself. They looked upon this tree as the cradle of their being, and it bore different names among different nations, and possessed different attributes.[5]

The tree of life, or the world tree, is "an image of the whole universe, or at least of our planet, that embodies the notion that all life is interrelated and sacred."[6] This mystical concept has been frequently associated with actual trees in the real world, adopting distinct shapes and traits depending on the era and area of the globe. Lotus trees, pomegranate trees, almond trees, and olive trees are among the many varieties that have embodied this myth. But the tree of life is ultimately a symbol of all trees. Behind their multifaceted physical manifestations, elucidates renowned anthropologist Edwin Oliver James, "lies the basic themes

of creation, redemption, and resurrection, resting upon the conception of an ultimate source of ever-renewing life at the centre of the cosmos, manifest and operative in the universe, in nature, and in the human order."[7] Author and tree mythology researcher Fred Hageneder further explains the universal nature of the tree:

> According to many of the teachings of ancient wisdom, the universe comprises a spiral or circular movement around a central axis, the *axis mundi*. And this centre pole has often been depicted as the *Tree of Life*, or *Universal Tree*.... It portrays the universe as much more than a lifeless, clockwork mechanism that blindly follows the laws of physics; rather, it presents our world as a living, evolving organism, imbued with divine spirit.[8]

Throughout the ages, different cultures developed their own concept of a tree of life, with all major religions around the world containing tales and legends of sacred trees. While pre-Christian Scandinavia had its Ash Yggdrasil, early Hinduism had its tree of Jiva and Atman, and later its Ashvastha, or Sacred Fig tree—also called Bodhi tree by Buddhists, and under which Gautama Buddha is believed to have meditated and attained enlightenment.

As for Christians, Jews, and Muslims, they all share the mystical tale of the tree of knowledge of good and evil, which originally came from ancient Sumer—a pre-Babylonian civilization spanning over three thousand years in Mesopotamia, modern-day Iraq. "There is, indeed, scarcely a country in the world where the tree has not at one time or another been approached with reverence or with fear, as being closely connected with some spiritual potency," affirms J. H. Philpot in *The Sacred Tree in Religion and Myth* (1897).[9] The Bible itself has several references to mystical trees, with the most popular being the tree of knowledge from the Book of Genesis—a tree situated in the center of the Garden of Eden and from which Adam was forbidden to eat. fig. 1 But perhaps one of the most bewildering religious manifestations of the tree of life is the Sephirotic tree—a mystical symbol, central to esoteric Judaism. fig. 2

Kabbalah (*aytz chayim* in Hebrew) is a Jewish mystical tradition, which translates as "received," an allusion to the teachings passed through generations or directly from God. A pivotal element of the Kabbalah wisdom is the Sephirotic tree: a diagram of ten circles symbolizing ten pulses, or emanations, of divine energy, called *sephirot* in Hebrew—the derivation of *sapphire*. fig. 3 The ten nodes of this schema, reading zigzaggedly from top to bottom, are deciphered in the following manner: (1) *Kether*—crown, (2) *Hokhmah*—wisdom, (3) *Binah*—understanding, (4), *Chesed*—mercy, (5) *Gevurah*—power, (6) *Tiferet*—beauty, (7) *Netzach*—eternity, (8) *Hod*—glory, (9) *Yesod*—foundation, (10) *Malkuth*—kingdom. Even though there are several interpretations to the Sephirotic tree, the diagram ultimately depicts the different stages of divine creation, indicating that the "Creator sent the energy down in a specific pattern from Kether to Malkuth,"[10] or in other words, from a sublime and intangible presence to a physical and earthly existence. Using the tree metaphor to represent the emanation of the Universe, a map of all existence, the Sephirotic tree has remained a powerful symbol over many centuries and still bears a great significance in the mystic study of the Torah.

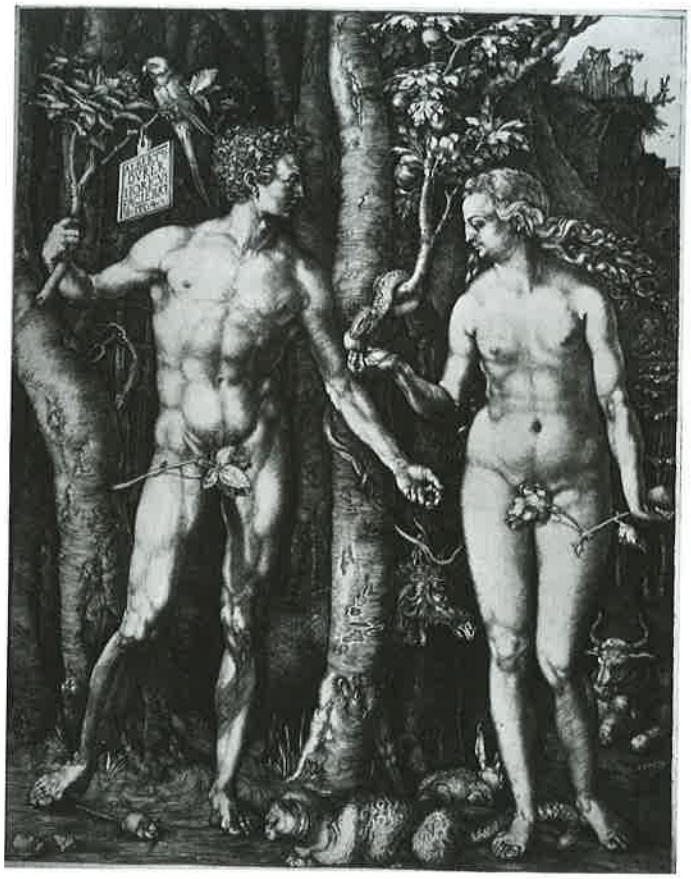


fig. 1

Albrecht Dürer, *The Fall of Man*, 1509

In this engraving depicting the famous biblical tale from the Book of Genesis, Adam and Eve stand in the Garden of Eden, with the tree of knowledge of good and evil in the background.

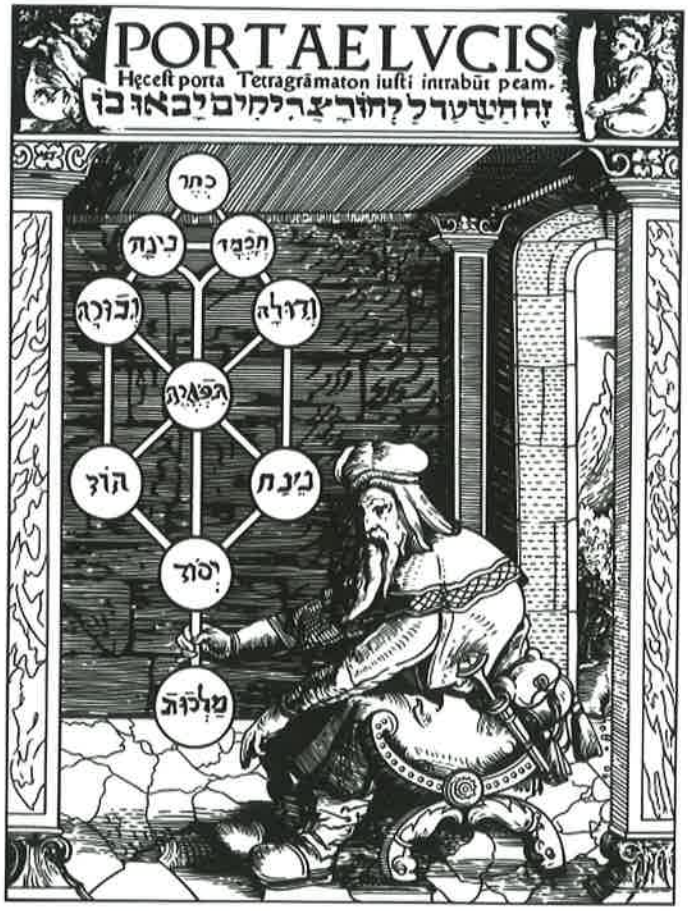


fig. 2

Sephirotic tree, from Paulus Riccius, *Portae lucis* (Doors of light), 1516

The pen-and-ink illustration depicts a Jewish Kabbalist meditating while holding the tree of life.

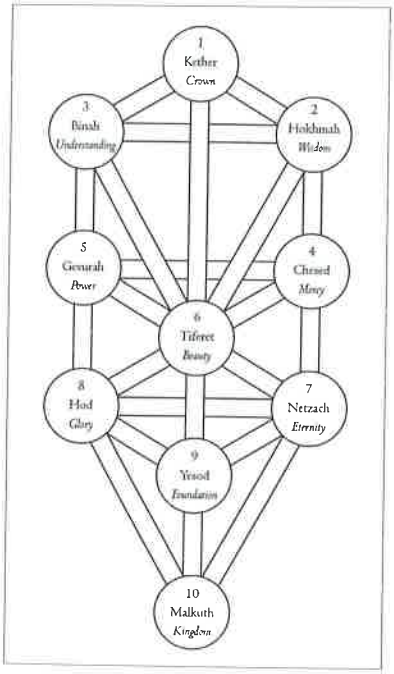


fig. 3

Sephirotic-tree diagram, from Rachel Pollack, *The Kabbalah Tree: A Journey of Balance & Growth*, 2004. © 2004 Llewellyn Worldwide, Ltd. Used with the permission of the publisher. All rights reserved.

Trees of Knowledge

Our primeval connection with nature and the tree might explain why its branched schema has not only been a symbol with sacred and pagan meanings but also an important metaphor for the classification of the natural world and the meanders of human understanding. Used to address social stratification, domains of human understanding, family ties, or evolutionary relationships between species, the tree has been a ubiquitous model since it can pragmatically express multiplicity (represented by its boughs, branches, twigs, and leaves) from unity (its central foundational trunk). fig. 4 Its arrangement implies a succession of subgroups from larger groups, which are in turn connected to a common root, or starting point. Because of this expressive quality, the metaphorical structure of a tree has been used for thousands of years, from early Sumerian times to modern-day science and operating systems. Currently the scheme still finds relevance in genetics, linguistics, archeology, epistemology, philosophy, genealogy, computer science, and library and information science, among many other areas. fig. 5 As Pollack eloquently puts it: "As the traditions of Western and Christian Kabbalah clearly demonstrate, the tree operates very well as a symbol for many systems of belief. It really has grown into a kind of organizing principle for our human efforts to understand the world."[11]

Most of us are familiar with the tree metaphor. You have probably seen an archetypal organizational chart of your company, a genealogical tree of your family, or perhaps a map of musical influences. While the metaphor is truly widespread, it is still possible to distill the use of trees, as an epistemological model, into two major domains: genealogy (in its broad philosophical sense, tracing the development of ideas, subjects, people, and society through history) and classification (a systematic taxonomy of values and subvalues). Whereas genealogy incorporates the tree to illustrate growth and subdivision over time, classification applies the hierarchical model to show our desire for order, symmetry, and regularity.

Portuguese scholar Olga Pombo, who has thoroughly investigated the classification of science, points to German philosopher Alwin Diemer as the progenitor of a fundamental framework for classification. In *Conceptual Basis of the Classification of Knowledge* (1974), Diemer divided the conventions of classification into four main domains: ontological (classification of species), informational (classification of information), biblioteconomical (classification of books), and gnosiological (classification of knowledge). (See also chapter 2, "Classifying Information," pages 61–64, and "Ordering Nature," pages 64–69.) Even though the ontological, informational, and biblioteconomical domains have been greatly marked by the tree model, it was in the gnosiological domain that the recursive metaphor of the tree had one of the most striking manifestations.

The idea of capturing the entirety of human knowledge and classifying it by means of a tree is an aged aspiration, a meme hundreds of years old. The biblical tree of knowledge, for instance, represented the collective knowledge of good and evil—forbidden to mankind under the penalty of death. The idea of an arboreal organizational scheme is so ingrained in our minds that we employ it figuratively in a variety of daily circumstances, which in turn conditions the way we understand things and express them to others. When we say "the root of a problem" or "the root of scientific research," we are alluding to some sort of hierarchical model with a defined

fig. 4

Genealogy of Henry II (973–1024), the Holy Roman Emperor, from Hartmann Schedel, *Nuremberg Chronicle*, 1493

In this genealogical scheme, the tree metaphor is taken literally, with the woman's womb depicted as the source of offshoots.

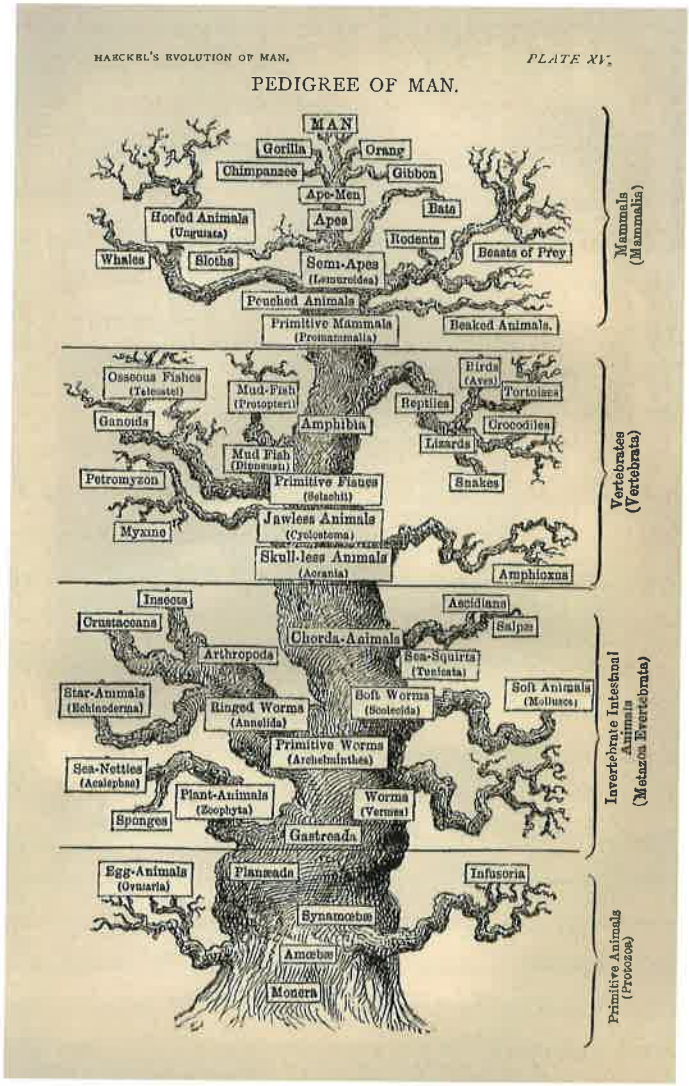


fig. 5

Ernst Haeckel, *Pedigree of Man*, 1879

Like many other early evolutionists, Haeckel believed that humans were the pinnacle of evolution—the highest form of life—as shown in this depiction of the tree of life, with man at the zenith.

foundation, a unifying basis. We also use it to convey the distinct areas of human knowledge, as in "the branches of science" or, more specifically, "genetics is a branch of science." The origin of the word *knowledge* itself is strongly tied to trees. "In the Germanic languages, most terms for learning, knowledge, wisdom, and so on are derived from the words for tree or wood," says Hageneder. "In Anglo-Saxon we have *witan* (mind, consciousness) and *witige* (wisdom); in English, 'wits,' 'witch,' and 'wizard'; and in modern German, *Witz* (wits, joke). These words all stem from the ancient Scandinavian root word *vid*, which means 'wood' (as in forest, not timber)."[12]

Early Pioneers

The earliest known concept for a hierarchical organization of knowledge comes to us from ancient Greece, through the work of one of its main characters: Aristotle. In *Categories*—the first of six works on logic, collectively called *Organon* (ca. 40 BCE)—Aristotle (384–322 BCE) delivers a fundamental vision on classification. He starts by exploring a series of semantic relationships, as in the equivocal, unequivocal, and derivative naming of things. He then presents the notion of the predicable, used in different forms of speech and the division of beings, before organizing every entity of human apprehension according to ten categories: substance, quantity, quality, relation, place, time, position, state, action, and affection. In the remaining text, Aristotle discusses in detail the definitions of all given categories and concludes with the different types of movement in nature (e.g., generation, destruction, increase). As professor of philosophy Anthony Preus explains, Aristotle's structure is not simply based in a tenfold classification but "suggests that each category serves as the genus for a group of immediately subordinate kinds, or species, which in turn serve as genera for further species subordinate to them, and so on until one reaches a level at which no further division is possible."[13]

This outstanding work is one of the most important philosophical treatises of all time and has been a long-lasting influence in Western culture. It grabbed the attention of innumerous philosophers over the centuries, such as Porphyry, René Descartes, Gottfried Leibniz, Immanuel Kant, and Martin Heidegger, all of whom variously defended, opposed, or modified Aristotle's original ideas. The cornerstone of Aristotle's philosophical theorizing, *Categories* laid the foundation for all subsequent classification efforts in a variety of scientific areas and still remains a subject of study and encouragement in the pursuit of a comprehensible universal categorization.

Tree of Porphyry

Porphyry (234–ca. 305 CE) was a Greek philosopher born in the city of Tyre, modern-day Lebanon. He is mostly renowned for his contribution to *The Six Enneads* (ca. 270 CE)—the only collection of writings by Porphyry's teacher and founder of Neoplatonism, the Greek philosopher Plotinus. But it was in his short introduction, or *Isagoge* (ca. 270 CE), to Aristotle's *Categories* that Porphyry made one of the most striking contributions to knowledge classification. In this highly influential introduction, translated into Latin by Anicius Manlius Severinus Boethius and disseminated across medieval Europe, Porphyry reframes Aristotle's original predicables into a decisive list of five classes: genus (*genos*), species (*eidos*), difference (*diaphora*), property (*idion*), and accident (*sumbebekos*). Most importantly, he introduces a hierarchical, finite structure of classification, in

what became known as the tree of Porphyry, or simply the Porphyrian tree. fig. 6

Expanding on Aristotle's *Categories* and visually alluding to a tree's trunk, Porphyry's structure reveals the idea of layered assembly in logic. It is made of three columns of words, where the central column contains a series of dichotomous divisions between genus and species, which derive from the supreme genus, Substance. Even though Porphyry himself never drew such an illustration—his original tree was purely textual in nature—the symbolic tree of Porphyry was frequently represented in medieval and Renaissance works on logic and set the stage for theological and philosophical developments by scholars throughout the ages. It was also, as far as we know, the earliest metaphorical tree of knowledge.

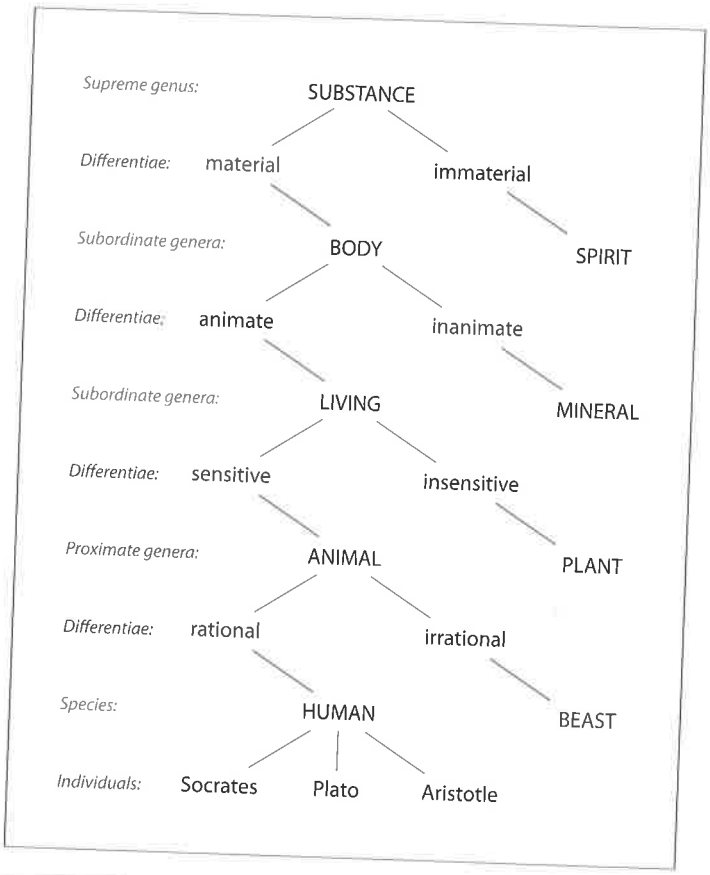


fig. 6

The porphyrian tree, the oldest known type of a classificatory tree diagram, was conceived by the Greek philosopher Porphyry in the third century AD. This figure shows a Porphyrian tree as it was originally drawn by the thirteenth-century logician Peter of Spain.

Liber figurarum (Book of figures)

Joachim of Fiore (ca. 1135–1202) was a twelfth-century Italian abbot and the founder of the monastic order of San Giovanni in Fiore, whose followers are called Joachimites. Very little is known with certainty about this extraordinary man, and most of his life accounts came to us from a biography published by a later monk of the monastery of Fiore, Jacobus Græcus Syllanæus, in 1612. Joachim opposed many religious dogmas and was a firm believer in a more liberal Church. He envisioned a new age in which mankind would reach total freedom and the hierarchy of the Church would become unnecessary under the rule of the Order of the Just, an alliance between Christians, Jews, and Muslims.

Some see Joachim of Fiore as a visionary and a prophet, others as a mere dissident. Still considered a heretic by the Vatican, Joachim of Fiore left behind a number of his writings and treatises that attest to his productive intellect. Among them is the extraordinary *Liber figurarum*, one of the most important and stunning collections of symbolic theology from the Middle Ages. fig. 7 The illustrations shown in the manuscript were conceived by Joachim in different stages of his life and published posthumously in 1202. They depict a variety of characters and institutions from the Old and New Testaments, and many employ an organic arboreal schema to highlight the centrality of Christ, the gradation of biblical protagonists, and the links with the past—as in the recurrent use of branches to symbolize the twelve tribes of Israel. fig. 8, fig. 9, fig. 10

fig. 7

The Tree of the Two Advents, from Joachim of Fiore, *Liber figurarum*, 1202

This remarkable figure presents the main characters and institutions of the Christian salvation history. From bottom to top: Adam, Jacob the Patriarch, Ozias the Prophet, and Jesus Christ (repeated twice). The figure of Christ dominates the center of the geneological tree (representing the first coming, or Redemption), as well as the very top (the place of the second coming, or Resurrection). The lower branches, originating from the figure of Jacob the Patriarch, correspond to the twelve tribes of Israel, and the top branches, radiating from the image of Jesus Christ, symbolize the twelve Christian churches.

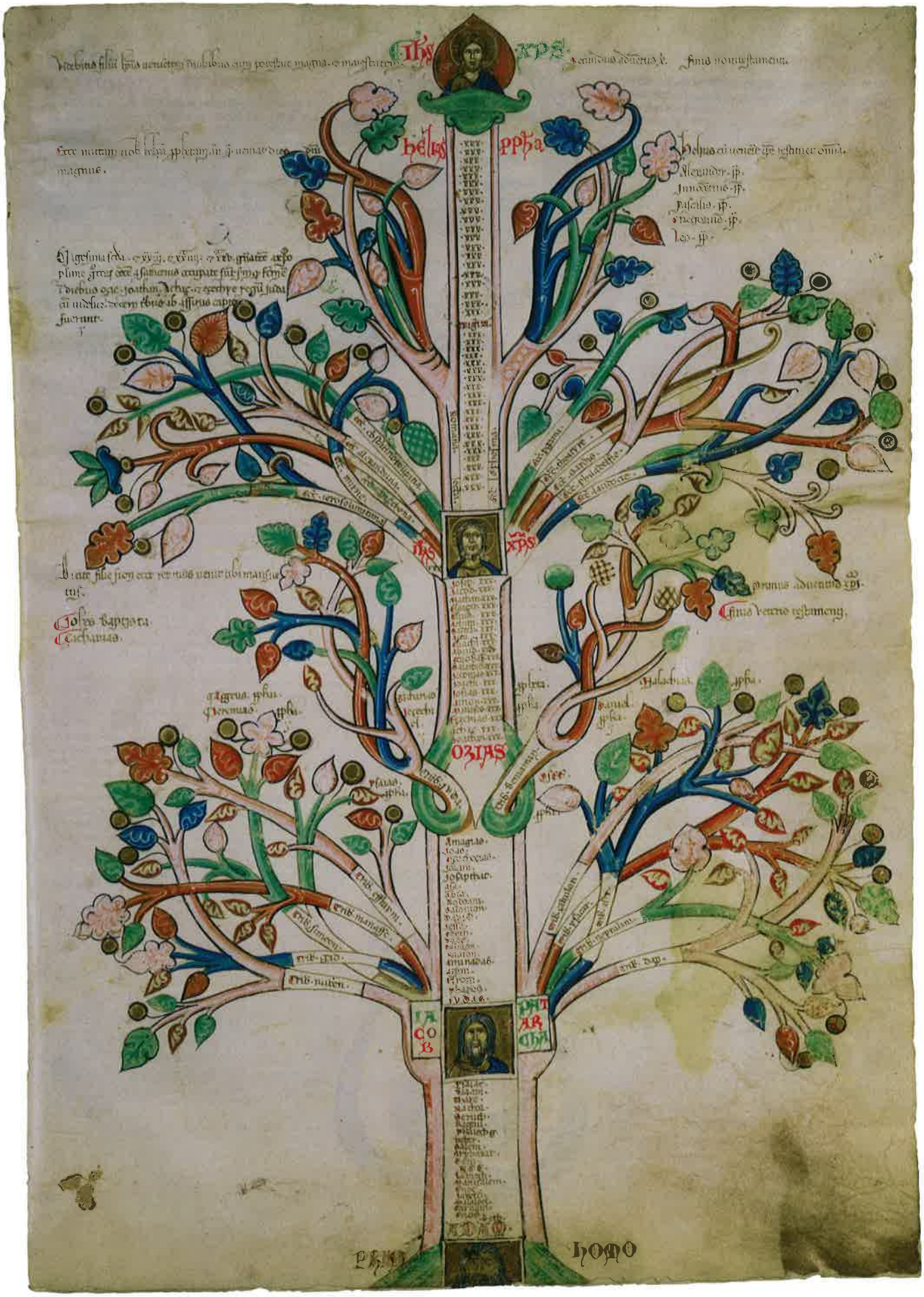

Verbum filii dei incarnetur
Ihs
xps
Helias
ppha
Ozias
Iacob
Maria
homo

fig. 8

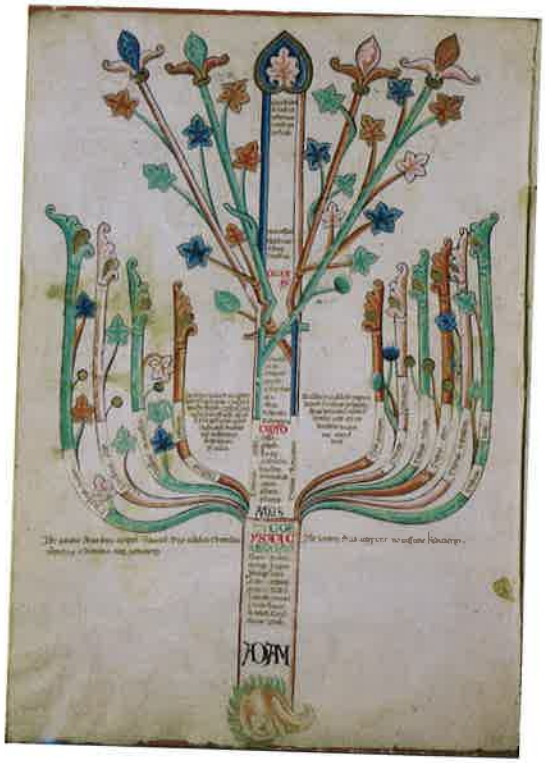
The Trinitarian Tree Circles, from Joachim of Fiore, *Liber figurarum*

This tree represents the development of the history of Christianity, divided into three circles, or states, of the world. At the bottom, Noah's tree (rooted in his three sons) gives origin to the first circle (age of the Father), leading to the second (age of the Son), and ultimately the third (age of the Holy Spirit). The amount of foliage increases in density toward the top, culminating in lush vegetation, symbolizing the glory of the universal church.

fig. 9

A Pair of Trees with Side-shoots, from Joachim of Fiore, *Liber figurarum*

A depiction of the Christian salvation history, with the names of its main protagonists stacked up along the two tree trunks. The first tree traces the Old Testament—Abraham, Isaac, Jacob, Joseph, Ephraim; and the second, the New Testament.



Editor Peter L. Heyworth sees this tree allegory as a teaching tool for the rich biblical heritage. "In this period, the art of preaching itself came to be likened to a tree. *Praedicare est arborizare* [to preach is to plant a tree]: the well-grown sermon must be rooted in a theme, that flourishes in the trunk of a biblical *auctoritas*, and thence grows into its branches and twigs: the divisions and subdivisions whereby the preacher extends his subject-matter."[14] The sermon *Praedicare est arborizare* is an example of a medieval formulation in which trees were often allegorized in relation to discursive phenomena, which in turn might explain why the tree metaphor is so prevalent in the illustrations featured in *Liber figurarum*. With a strong theological nature, *Liber figurarum* represents a remarkable effort of systematization of historical accounts, events, and social ties by means of trees and is a seminal work in this period of history.

Arbor scientiae (Tree of science)

Born in the Spanish Balearic island of Mallorca in 1232, Ramon Llull (1232–1315) was one of the most astonishing figures of medieval Europe. A poet, mystic, philosopher, and devout Christian, he wrote one of the earliest, if not the first, European novel, *Blanquerna* (1283), and was the spearhead of the consolidation of the Catalan language. Llull left behind more than 250 works in Catalan, Latin, and Arabic, with many more subsequent translations into French, Spanish, and Italian. His most renowned piece is *Ars magna* (The great art), first published in 1271 as *Ars magna primitiva* (The first great art) and recurrently iterated by Llull in subsequent editions over thirty years.

But one of Llull's most well-known works, pertaining to knowledge representation, was his wonderful *Arbor scientiae* from 1296, which includes a magnificent compilation of sixteen trees of scientific domains following a leading tree, itself called the arbor scientiae. fig. 11 An expression of his mystical universalism, this encyclopedic work concentrates on the central image of a tree of science, able to sustain all areas of knowledge.[15] Appearing in the very beginning of the book, the illustration of the tree of science works as an introduction to his beguiling concept and a sort of arborescent table of contents. This great tree comprises eighteen roots, which relate to nine transcendent principles (not detailed) and nine art principles: difference, concord, contrariety, beginning, middle, end, majority, equality, and minority. The top of the tree is made of sixteen branches, each bearing a fruit and a label, representing the different domains of science, which are then depicted as individual trees in the remaining pages of the work.

The first set of trees relates to profane knowledge and includes the *arbor elementalis* (physics, metaphysics, and cosmology), the *arbor vegetalis* (botany and medicine), the *arbor sensualis* (animals and sensible beings), the *arbor imaginalis* (mental entities, psychology), the *arbor humanalis* (anthropology and the studies of man), the *arbor moralis* (ethics, moral vices, and virtues), and the *arbor imperialis* (government and politics of a prince). fig. 12 The second group covers the entirety of religious knowledge and comprises the *arbor apostolocalis* (ecclesiastical studies and the organization of the church), the *arbor celestialis* (astronomy and astrology), the *arbor angelicalis* (angels), the *arbor eviternalis* (immortality, the afterlife, hell and paradise), the *arbor maternalis* (the study of Virgin Mary), the *arbor christinalis* (christology), and the *arbor divinalis* (theology). There are two additional trees, *arbor exemplificalis* and *arbor quaestionalis*. The first contains a series of metaphorical examples pertaining to the four

fig. 10

The Tree-Eagle (Old Dispensation), from Joachim of Fiore, *Liber figurarum*

The eagle, a powerful symbol of spiritual enlightenment and contemplation, is prominently featured in this tree that depicts the advent of the age of the Holy Spirit. The central trunk lists various generations in the history of Christianity, from Adam to Zorobabel, while the lower branches symbolize the twelve tribes of Israel, separated by the tribes that first entered the promised land (left) and the tribes that arrived later (right).

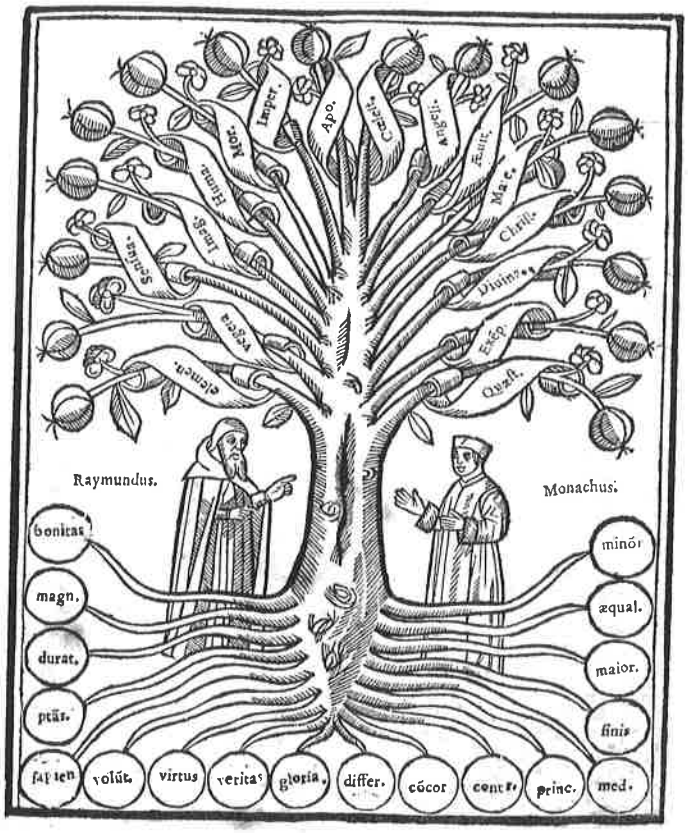


fig. 11 (left)

Arbor scientiae (Tree of science), from Ramon Llull, *Arbor scientiae venerabilis et coelitus illuminati Patris Raymundi Lullii maioricensis Liber ad omnes scientias utilissimus*, 1515

fig. 12

Arbor moralis (Moral tree), from Llull, *Arbor scientiae venerabilis*

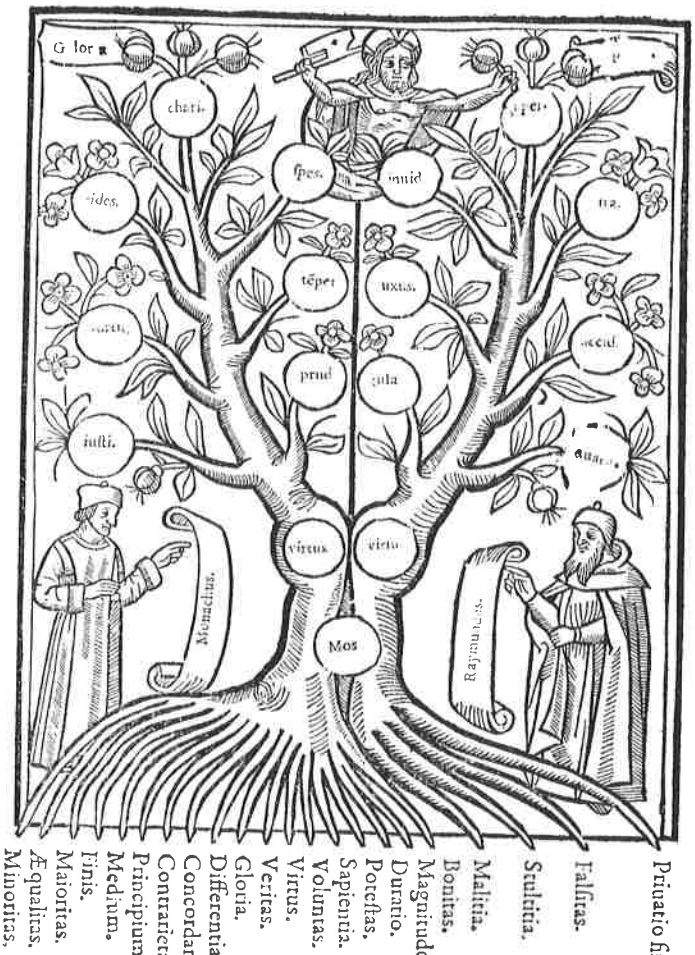


fig. 13

Diagrams of Llull's intriguing combinatory-logic concepts, from Llull, *Ars Brevis V.M.B. Raymundi Lullij Tertij Ord. S. Francisci, Doc. Illu.: mendis castigata, Capitibus Divisa, atque scholiis locupletata*, 1669

PRIMA FIGVRA.

SECVNDA FIGVRA.

TERTIA FIGVRA.

BC	CD	DE	EF	FG	GH	HI	IK
BD	CE	DF	EG	FH	GI	HK	
BE	CF	DG	EH	FI	GK		
BF	CG	DH	EI	FK			
BG	CH	DI	EK				
BH	CI	DK					
BI	CK						
BK							

natural elements (fire, water, earth, and air), with the goal of transforming science into an accessible narrative, while the second features a large body of four thousand questions related to the preceding trees.

Despite Llull's magnificent arrangement of the trees of science, which centuries later influenced the classification efforts of Francis Bacon and René Descartes, his most recognized contribution to European thinking was the pursuit of an "organic and unitary corpus of knowledge and a systematic classification of reality," which included a series of diagrams, symbolic notations, and mechanical apparatuses.[16] fig. 13 This approach was instrumental in the research of German philosopher and mathematician Gottfried Leibniz (1646–1716), particularly in his conception of an imaginary universal language capable of expressing the most sophisticated mathematical, scientific, and metaphysical concepts—the famous *characteristica universalis* (universal characteristic). Leibniz first mentioned this lexicon made of pictographic characters, which reduces all debate to calculation, in his *Dissertatio de arte combinatoria* (Dissertation on the combinatorial art), published when Leibniz was only nineteen. This vocabulary created the seed for the later development of the binary system—the foundation of all modern computers—that Leibniz eventually presented in his ingenious *Explication de l'arithmétique binaire* (Explanation of binary arithmetic), published in 1705.

Encyclopedism

The desire for gathering the sum of human knowledge in a comprehensive compendium is as old as our desire to organize it. The earliest known attempt to do so appeared in the form of *Naturalis historia* (Natural history), published in 80 AD, a thirty-seven-chapter encyclopedia describing different aspects of the natural world and human developments in art, architecture, and medicine, among other domains, written by Pliny the Elder, a Roman statesman. Leading up to the Middle Ages, the seminal *Etymologiae* (ca. 630 AD), by the prolific scholar Saint Isidore of Seville, is one of the most significant encyclopedic ventures. The work comprised 449 chapters in twenty volumes and encapsulated much of the knowledge of the age. Later on Bartholomeus Anglicus's *De proprietatibus rerum* (1240) became one of the most read encyclopedias of the time, while Vincent of Beauvais's *Speculum majus* (1260) was the most comprehensive—with over three million words. But it was in the midst of the French Renaissance that one of the most consequential efforts at rationalizing knowledge took place, by the hands of French scholar Christophe de Savigny.

Tableaux accomplis de tous les arts libéraux (Complete tables of all liberal arts)

In 1587 de Savigny published in Paris the magnificent *Tableaux accomplis de tous les arts libéraux*. This pivotal work contains sixteen beautifully decorated tables covering the following arts and sciences (in the order they appear in the book): grammar, rhetoric, dialectic, arithmetic, geometry, optics, music, cosmography, astrology, geography, physics, medicine, ethics, jurisprudence, history, and theology. The book is solely composed of the sixteen tables, each one

accompanied by a corresponding one-page description. In every table, a tree of interrelated topics takes center stage, surrounded by an oval ornamental piece containing various graphic elements pertaining to the depicted discipline. fig. 14 *Tableaux accomplis de tous les arts libéraux*, one of the most enticing medieval pieces on the rationalization and visual representation of knowledge, became an important influence on the subsequent work of Bacon, ultimately consolidating the widespread use of the tree metaphor.

The consolidation: Francis Bacon and René Descartes

In 1605 English philosopher and fervent promoter of the Scientific Revolution Bacon (1561–1626) published one of the major landmarks in the history of science, and arguably the most significant philosophical work in English until then. In *The Advancement of Learning*, Bacon not only suggests a new science of observation and experimentation, as a substitute to secular Aristotelian science, but also explores with great minutia the wide arrangement of all human knowledge, from the general to the particular. He starts by dividing man's understanding into three main parts: "History to his Memory, Poesy [poetry] to his Imagination, and Philosophy to his Reason."[17] He then suggests various subdivisions to the three main categories and drills down to its key disciplines, such as physics, mathematics, and anatomy, describing and contextualizing them in great detail. During his expositions he alludes to the tree of knowledge: "The distributions and partitions of knowledge are not like several lines that meet in one angle, and so touch but in a point; but are like branches of a tree, that meet in a stem, which hath a dimension and quantity of entireness and continuance, before it comes to discontinue and break itself into arms and boughs."[18]

While this effort on the classification of knowledge is thought to have been inspired by de Savigny's pictorial encyclopedia, produced a few years before, Bacon's essay fostered much of the subsequent thinking in scholarly circles, making him the great precursor of modern encyclopedism and a key influence in Descartes's conception of the tree of knowledge.

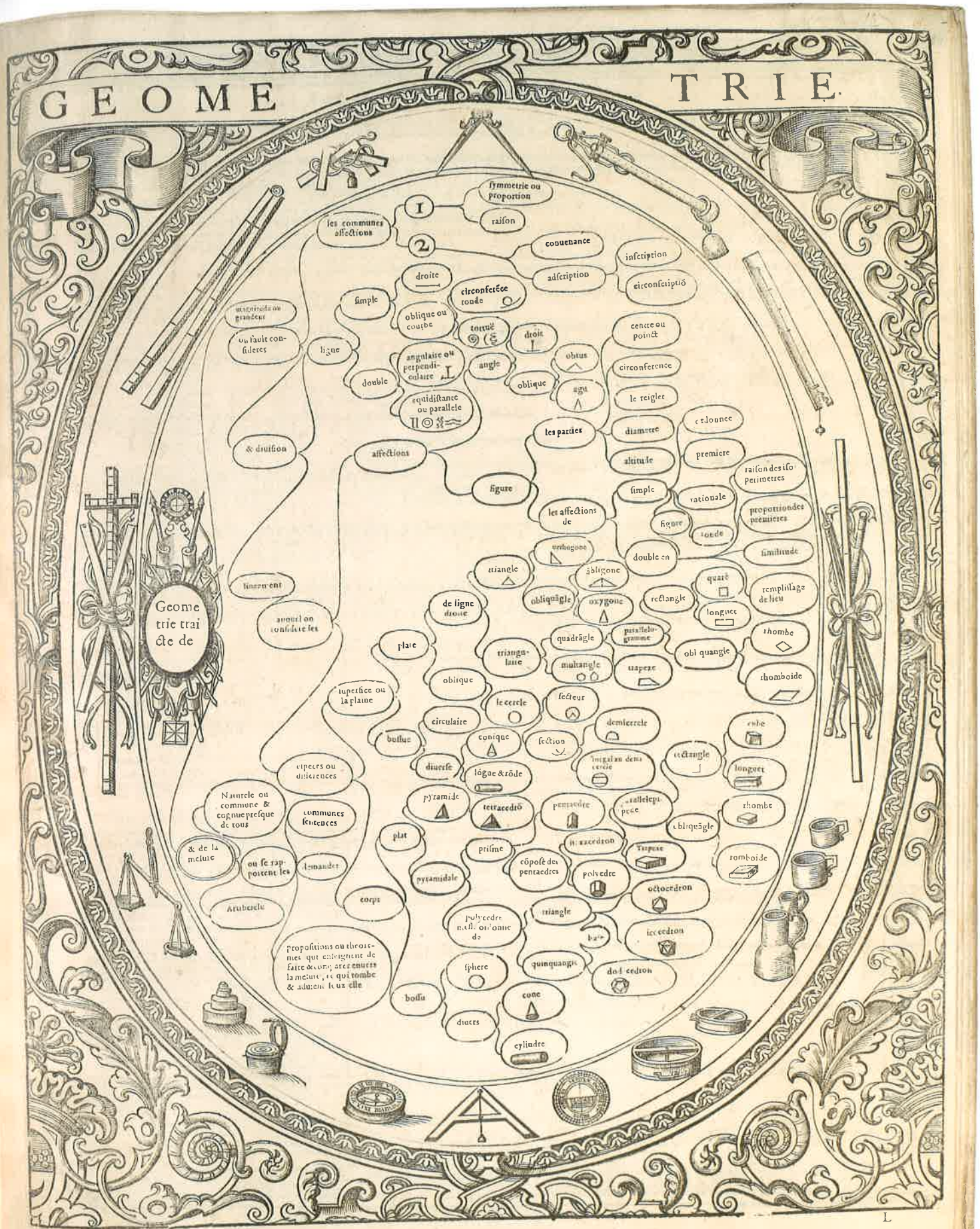
Descartes (1596–1650), often called the father of modern philosophy, continued exploring Bacon's ideas on the arboreal scheme of science in many of his works, including *The World* (1629–33), *Dioptrics* (1637), *Meteorology* (1637), and *Geometry* (1637). But it was in his *Principia philosophiae* (*Principles of Philosophy*) (1644), his longest and most ambitious piece, that Descartes delved further into the topic. This exceptional work was meant to have six parts (although he only concluded the first four): I—The Principles of Human Knowledge, II—The Principles of Material Things, III—The Visible Universe, IV—The Earth, V—Living Things, VI—Human Beings. The 207 completed principles are normally short (one paragraph each) and resemble a list of small knowledgeable units, a synthesis of most of his theories in philosophy and physics, dealing with everything from geometry to the perception of the senses.

In a letter to the French translator of the work, while explaining the rationale behind the principles, Descartes describes his image of the tree of knowledge:

> Thus, all Philosophy is like a tree, of which Metaphysics is the root, Physics the trunk, and all the other sciences the branches that grow out of this trunk, which are reduced to three principles, namely, Medicine, Mechanics, and Ethics.... But as it is not from the roots or the

fig. 14

Geometry, from Christophe de Savigny, *Tableaux accomplis*, 1587


GEOME
TRIE.
Geome trie trai ctede
symmetrie ou proportion
raison
les communes affections
1
2
conuenance
adscription
inscription
circonscriptiõ
droite
circonferẽce ronde
simple
oblique ou courbe
tortuë
droit
ligne
double
angulaire ou perpendiculaire
angle
obtus
aigu
oblique
equidistance ou parallele
centre ou poinct
circonference
le reiglet
les parties
diametre
altitude
ordonnee
premiere
affections
figure
& diuision
les affections de
simple
rationale
figure
ronde
raison des iso perimetres
proportiõnees premieres
similitude
double en
orthogone
triangle
ãbligone
obliquãgle
oxygone
quarré
rectangle
longuet
remplissage de lieu
de ligne droite
plate
triangulaire
quadrãgle
parallelogramme
multangle
trapeze
obl quangle
rhombe
rhomboide
superfice ou la plaine
obliques
le cercle
secteur
circulaire
demicercle
cube
boſſue
conique
section
diuerſe
lõgue & rõde
inegal en dem cercle
rectangle
longuet
especes ou differences
Naturele ou commune & cognue presque de tous
communes sentences
& de la meſure
ou se rapportent les
demandes
pyramide
terraedrõ
pentaedre
parallelepipede
rhombe
obliquãgle
plat
prisme
hexaedron
Trapeze
pyramidale
cõpoſé des pentaedres
polyedre
rhomboide
octoedron
Aruberele
corps
triangle
polyedre reſſemblant
base
icoedron
propositions ou theoremes qui enseignent de faire & corriger les erreurs de la meſure, ce qui tombe & aduient touz elle
quinquangle
dodecedron
sphere
cone
boſſu
diuers
cylindre

> trunks of trees that we gather the fruit, but only from the extremities of their branches, so the principal utility of philosophy depends on the separate uses of its parts, which we can only learn last of all.[19]

While neither Bacon nor Descartes developed a visual representation of the tree of knowledge, it is through their words that we can ascertain the construction of such a hierarchical classification scheme, which contributed decisively to the establishment of the general metaphor of the tree as the underlying epistemological model of all sciences.

Cyclopædia

Published in 1728 and composed of two volumes, this work by Ephraim Chambers was one of the earliest general encyclopedias written in English. The noticeably long full title of the piece describes its holistic aim: *Cyclopædia, or, An universal dictionary of arts and sciences: containing the definitions of the terms, and accounts of the things signify'd thereby, in the several arts, both liberal and mechanical, and the several sciences, human and divine: the figures, kinds, properties, productions, preparations, and uses, of things natural and artificial: the rise, progress, and state of things ecclesiastical, civil, military, and commercial: with the several systems, sects, opinions, etc: among philosophers, divines, mathematicians, physicians, antiquaries, criticks, etc: the whole intended as a course of ancient and modern learning.*

One of the most significant achievements of *Cyclopædia*, with respect to knowledge classification, was the introduction of a horizontal tree diagram, in which the hierarchical ordering of subjects reads from left to right, instead of the common top-down or bottom-up arrangement. fig. 15, fig. 16 The leftmost branch of knowledge has a series of sub-branches (e.g., artificial, external, real) before reaching the final, rightmost branches (e.g., astronomy, geography, sculpture), which represent particular sections in the book and fulfill the goal of the chart to serve as a table of contents. Bearing a strong resemblance to the successive forking of the Porphyrian tree, the diagram maps forty-seven different disciplines in the book, including meteorology, geometry, alchemy, architecture, commerce, medicine, and poetry. We can once more perceive the tree metaphor, not only to express the various relations between the topics, but also as a unifying element, connecting all areas of knowledge under the same foundation.

Encyclopédie

During the mid-eighteenth century, in the height of French Enlightenment, one of the most astounding encyclopedic efforts took place by Denis Diderot and Jean le Rond d'Alembert. First published in 1751, the *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers* (Encyclopedia, or a systematic dictionary of the sciences, arts, and crafts) was one of the largest encyclopedias produced until then, accounting for 20 million words in 71,818 articles and 3,129 illustrations over thirty-five volumes. Inspired by a French translation of Chambers's *Cyclopædia*, *Encyclopédie* became an important drive for the subsequent launch of *Encyclopedia Britannica* seventeen years later, and a precursor to many modern encyclopedias.

This innovative encyclopedia paid special attention to the mechanical arts, and it was the first to include contributions from well-known authors, many of the great names of French Enlightenment among them, such as

KNOWLEDGE, is either

- *Natural* and *Scientifical*, which is either
  - *Sensible*; consisting in the Perception of Phænomena, or External Objects——called PHYSIOLOGY, or NATURAL HISTORY; and which according to the different Kinds of such Objects, divides into
    - METEOROLOGY [1].
    - HYDROLOGY [2].
    - MINEROLOGY [3].
    - PHYTOLOGY [4].
    - ZOOLOGY [5].
  - OR,
  - *Rational*; consisting in the Perception of the intrinsick Characters or Habitudes of sensible Objects—either
    - Their *Powers* and *Properties*—called PHYSICKS, and NATURAL PHILOSOPHY [6].
    - *Abstracts* thereof—called METAPHYSICS [7] which subdivides into
      - ONTOLOGY.
      - PNEUMATOLOGY.
    - *Quantities* thereof, called MATHEMATICS—which divides, according to the Subject of the Quantity, into
      - ARITHMETIC [8]—whence
        - ANALYTICS [9].
        - ALGEBRA [10].
      - GEOMETRY [11]—whence
        - TRIGONOMETRY.
        - CONICS.
        - SPHERICS.
      - STATICS [12].
    - *Relations* thereof to our Happiness—called RELIGION, or the Doctrine of OFFICES, which subdivides into
      - ETHICS [13], or NATURAL RELIGION—whence
        - POLITICS [14].
        - LAW [15].
      - THEOLOGY [16], or REVELATION.
- OR,
- *Artificial* and *Technical*, (consisting in the Application of Natural Notices to further Purposes) which is either
  - *Internal*; employ'd in discovering their Agreement and Disagreement; or their Relations in respect of Truth—call'd LOGICS [17].
  - OR,
  - *External*, which is either——
    - *Real*, employ'd in discovering and applying the——
      - Further *Powers* and *Properties* of Bodies—called CHYMISTRY [18]—whence
        - ALCHEMY.
        - NATURAL MAGIC, *&c.*
      - *Quantities* of Bodies—call'd MIX'D MATHEMATICS; which according to the different Subjects resolves into
        - OPTICS [19], CATOPTRICS, DIOPTRICS——whence
          - PERSPECTIVE [20].
          - PAINTING [21].
        - PHONICS——whence MUSICK [22].
        - HYDROSTATICS [23], HYDRAULICS.
        - PNEUMATICS [24].
        - MECHANICS [25]——whence
          - ARCHITECTURE [26].
          - SCULPTURE [27].
          - TRADES [28], and MANUFACTURES.
        - PYROTECHNIA [29]—whence
          - The MILITARY *Art* [30].
          - FORTIFICATION [31].
        - ASTRONOMY [32]——whence
          - CHRONOLOGY [33].
          - DIALLING [34].
        - GEOGRAPHY [35], HYDROGRAPHY——whence
          - NAVIGATION [36].
          - COMMERCE [37].
      - *Structure* and *Oeconomy* of Organical Bodies——called ANATOMY [38].
      - OR,
      - *Relations* thereof to the Preservation and Improvement—either of
        - Animals——called
          - MEDICINE [39].
          - PHARMACY [40].
        - Vegetables—called
          - AGRICULTURE [41].
          - GARDENING [42].
        - Brutes——called FARRYING [43], MANAGE——whence
          - HUNTING.
          - FALCONRY.
          - FISHING, *&c.*
    - *Symbolical*, employ'd in framing
      - *Words*, or Articulate Signs of Ideas——called GRAMMAR [44].
      - *Figures*——called RHETORIC [45]—whence The making of *Armories*, called HERALDRY [46].
      - *Fables*——called POETRY [47].

fig. 16

Table of contents, from Chambers, *Cyclopaedia*

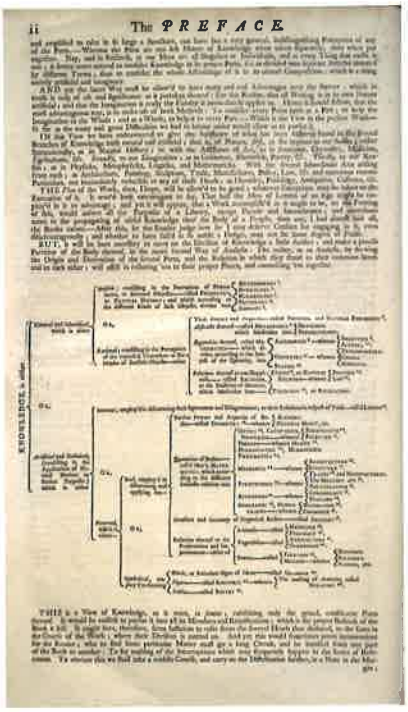


fig. 15

Table of contents as it appears in the preface of the original publication, from Ephraim Chambers, *Cyclopædia, or, An universal dictionary of arts and sciences*, 1728

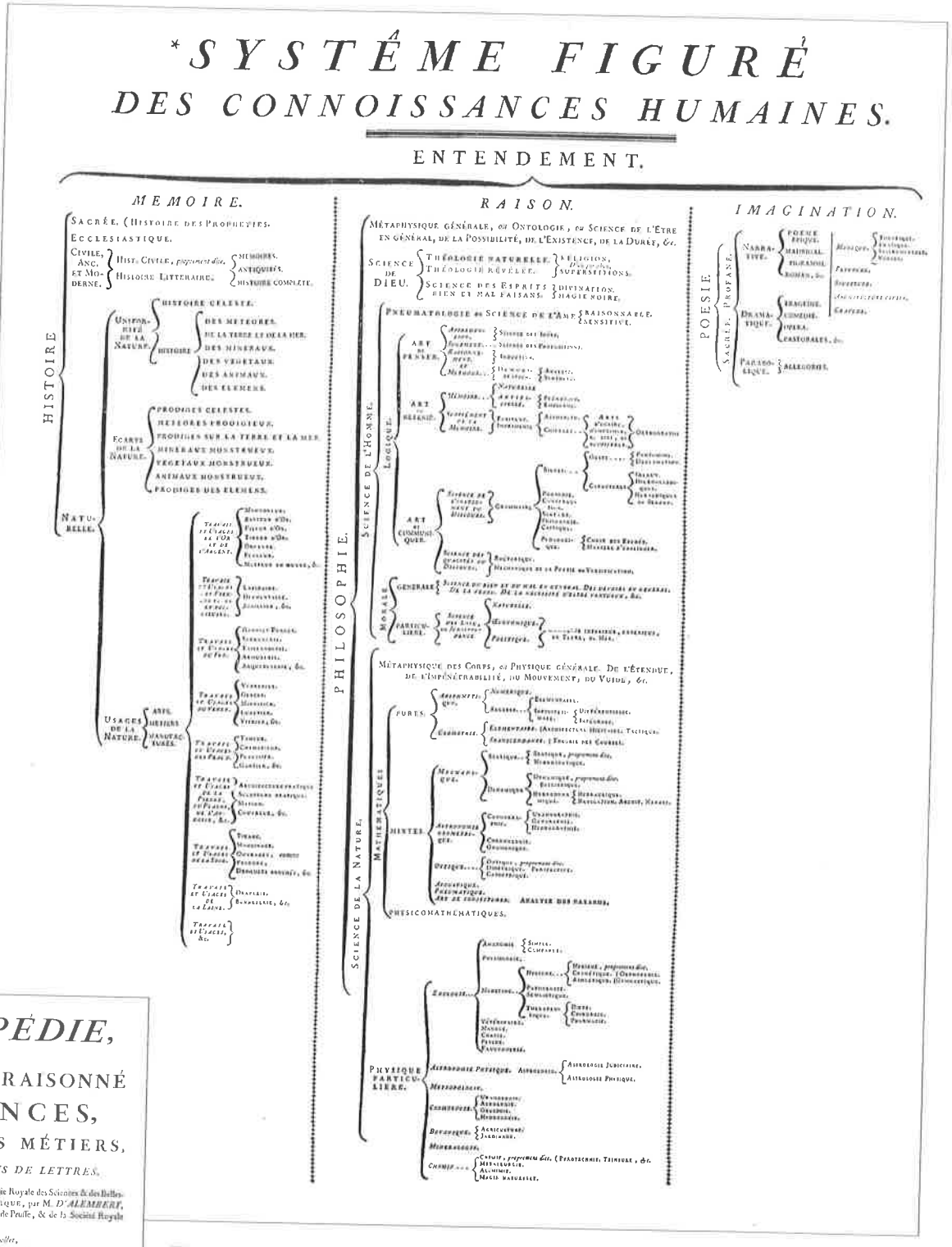


fig. 17

Title page, from Denis Diderot and Jean le Rond D'Alembert, *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers* (Encyclopedia, or a systematic dictionary of the sciences, arts, and crafts), 1751

fig. 18

Système figuré des connaissances humaines (Figurative system of human knowledge), from Diderot and D'Alembert, *Encyclopédie*

ENCYCLOPÉDIE,

OU

DICTIONNAIRE RAISONNÉ DES SCIENCES,

DES ARTS ET DES MÉTIERS,

PAR UNE SOCIÉTÉ DE GENS DE LETTRES.

Mis en ordre & publié par M. *DIDEROT*, de l'Académie Royale des Sciences & des Belles-Lettres de Prusse; & quant à la PARTIE MATHÉMATIQUE, par M. *D'ALEMBERT*, de l'Académie Royale des Sciences de Paris, de celle de Prusse, & de la Société Royale de Londres.

Tecum felix conjunxque pollet,
Tecum de medio furpuit mundus honoris! HORAT.

TOME PREMIER.

A PARIS,

Chez { BRIASSON, *rue Saint Jacques, à la Science.*
DAVID l'aîné, *rue Saint Jacques, à la Plume d'or.*
LE BRETON, *Imprimeur ordinaire du Roy, rue de la Harpe.*
DURAND, *rue Saint Jacques, à Saint Landry, & au Griffon.*

M. DCC. LI.

AVEC APPROBATION ET PRIVILEGE DU ROY.

Voltaire, Montesquieu, and Rousseau. Diderot's article "Encyclopedia" indicates his main motivation behind this pursuit: "Indeed, the purpose of an encyclopedia is to collect knowledge disseminated around the globe; to set forth its general system to the men with whom we live, and transmit it to those who will come after us, so that the work of preceding centuries will not become useless to the centuries to come."[20]

Diderot believed an encyclopedia to be, above all, a directory of associations, where the connections between the different areas of science could be exposed and further pursued by each individual reader. "Every science overlaps with others: they are two continuous branches off a single trunk,"[21] asserts Diderot. The branching analogy appears once again. In the same article, Diderot expresses an intriguing vision of the future, reminiscent of our now ubiquitous hypertext:

> Thanks to encyclopedic ordering, the universality of knowledge, and the frequency of references, the connections grow, the links go out in all directions, the demonstrative power is increased, the word list is complemented, fields of knowledge are drawn closer together and strengthened; we perceive either the continuity or the gaps in our system, its weak sides, its strong points, and at a glance on which objects it is important to work for one's own glory, or for the greater utility to humankind. If our dictionary is good, how many still better works it will produce![22]

This conception of an encyclopedia as a growing organism with many possible directions, as a map of scientific domains, explains why Diderot and d'Alembert included an illustration of the collective knowledge of humankind in the *Encyclopédie*. The piece entitled *Système Figuré des Connaissances Humaines* (Figurative system of human knowledge), and later called the tree of Diderot and d'Alembert, was first featured in the original 1751 edition and executed by French designer and engraver Charles-Nicolas Cochin. fig. 17, fig. 18 The scheme organizes all areas of science (knowledge) under three main branches: memory (or history), reason (or philosophy), and imagination (or poetry). If conceptually the scheme is inspired by Bacon's classification, graphically it has a clear similitude to Chambers's tree diagram in *Cyclopædia*, showcasing an analogous succession of curly brackets from higher to lower categories.

In 1780 an alternative version of the original illustration was made, this time as a much more literal arboreal metaphor. *Essai d'une distribution généalogique des sciences et des arts principaux* (Genealogical distribution of arts and sciences) was featured as a fold-out frontispiece in the *Table analytique et raisonnée des matieres contenues dans les XXXIII volumes in-folio du Dictionnaire des sciences, des arts et des métiers, et dans son supplement.* figs. 19–20 This tree depicts a genealogical distribution of knowledge, with its three prominent branches matching the early diagram: memory/history (left), reason/philosophy (center), and imagination/poetry (right). The heavy tree bears fruits of different sizes, representing the different domains of science, in an intricate branching configuration. Its slightly unbalanced look is caused by the dominance of the central bough of philosophy, which holds most of the tree's branches and shadows the withered ones of history and poetry.

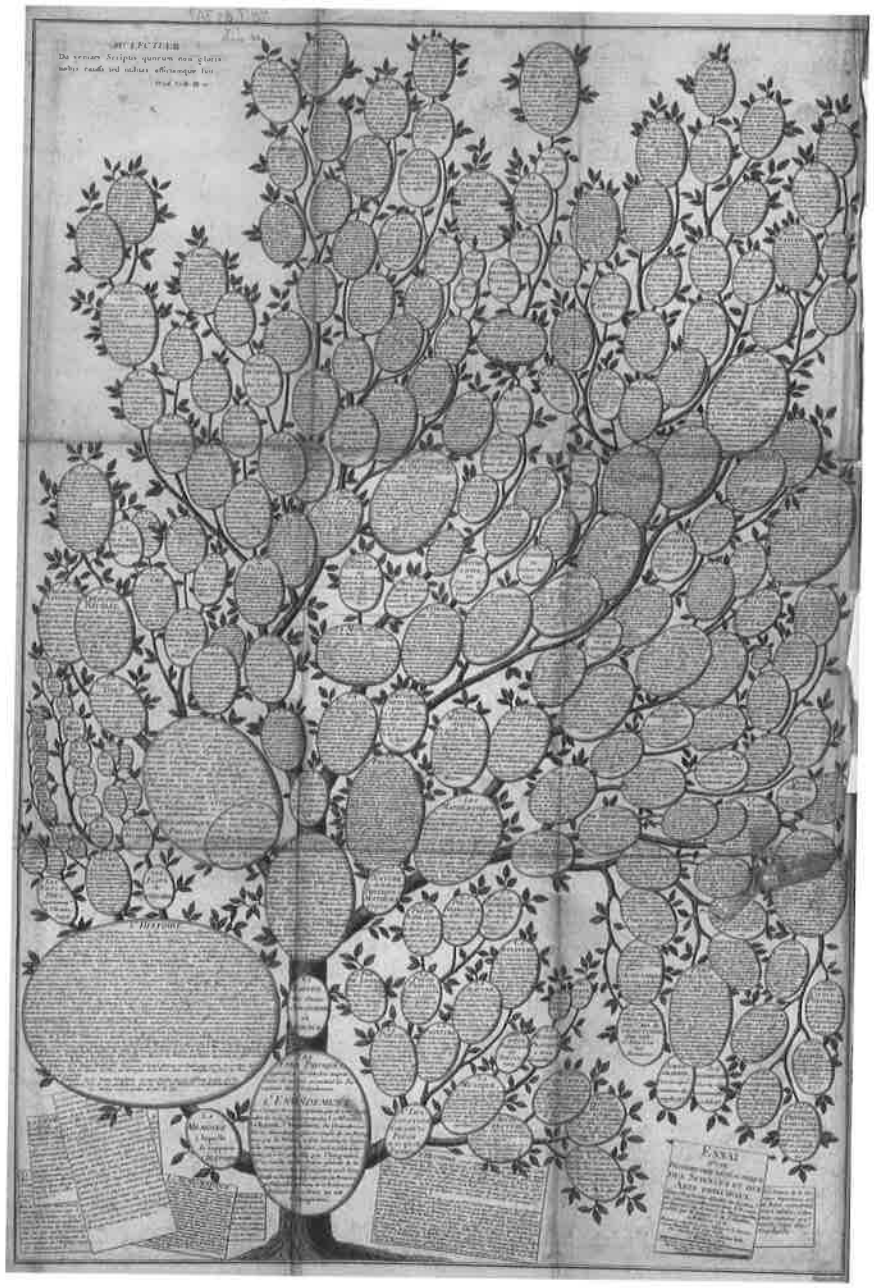


fig. 19

Chrétien Frederic Guillaume Roth, *Essai d'une distribution généalogique des sciences et des arts principaux* (Genealogical distribution of arts and sciences), from Diderot and D'Alembert, *Encyclopédie*

fig. 20

Detail of *Essai d'une distribution généalogique*

The End of an Era

Various types of depictions of trees mapping an incredible array of topics have surfaced throughout the decades. The descendants of these ancient tree diagrams are still an integral part of the structure and navigation of most modern computer systems, allowing one to browse, filter, and organize files in a nested hierarchy. Nonetheless, the *Essai d'une distribution généalogique des sciences et des arts principaux* marked the end of the golden age of embellishment, in which trees were seen as powerful figures embedded with loftier connotations. Over time, tree diagrams acquired a generic nonfigurative design and became utilitarian tools rigorously studied by those in computer science and the mathematical field of graph theory. Even though they have lost most of their allegorical symbolism, contemporary tree models still use many labels of the past (e.g., root, branches, leaves). Today trees are used in the representation of taxonomic knowledge in a variety of subject areas; and, as an exceptionally suitable scheme in the modeling of hierarchical structures, they will most certainly continue their widespread sphere of influence well into the future.

Notes

1 Pollack, *The Kabbalah Tree*, 2.
2 Bates, *The Real Middle Earth*, 44.
3 Ibid.
4 Philpot, *The Sacred Tree in Religion and Myth*, 3.
5 Porteous, *The Forest in Folklore and Mythology*, 191.
6 Hageneder, *The Living Wisdom of Trees*, 8.
7 James, *The Tree of Life*, 1.
8 Hageneder, *The Living Wisdom of Trees*, 8.
9 Philpot, *The Sacred Tree in Religion and Myth*, 1.
10 Pollack, *The Kabbalah Tree*, xvi.
11 Ibid., xvii.
12 Hageneder, *The Living Wisdom of Trees*, 8.
13 Preus and Anton, *Essays in Ancient Greek Philosophy V*, 19.
14 Heyworth, *Medieval Studies for J. A. W. Bennett*, 216.
15 Pombo, "Combinatória e Enciclopédia em Rámon Lull."
16 Rossi, *Logic and the Art of Memory*, 38.
17 Bacon, *Francis Bacon*, 175.
18 Ibid., 189.
19 Ibid.
20 Diderot, "Encyclopedia."
21 Ibid.
22 Ibid.